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ANALYSIS OF TECHNOLOGICAL PROCESS OF CUTTING LOGS USING ISHIKAWA DIAGRAM

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Abstract: *The quality management system standards of the ISO 9000:2000 series are based on the eight quality management principles. Principle No. 6 says: "Continual improvement of the organization's overall performance should be a permanent objective of the organization". Applying this principle requires having knowledge of methods and tools for solving problems and/or continual improvement. One of these tools is "The Cause & Effect Diagram". It is used to document the possible causes of a given event. "The Cause & Effect Diagram" is also known as a "Fishbone Diagram" because of its appearance or an "Ishikawa Diagram" after its originator, Dr Kaoru Ishikawa. In order to ensure its place at the market an organization has to produce such products and services that meet wishes and expectation of customers. It has to meet demand of customers and other interested parties (workers, owners, suppliers, community). However, due to strong competition and increased customer's requirements for higher quality, the organization could lost its place at the market if fails to make continuous improvements. Continuous improvements are not possible without knowing how to correctly implement both tools and methods. Task of management is to recognize the importance of tools and methods for management of quality, what is the subject of this paper.*
Keywords: *Ishikawa diagram, management of quality, tools and methods, improvement*

1. INTRODUCTION (Kaoru Ishikawa – Cause – Effect diagram creator)

Kaoru Ishikawa (1915 – 1989) is the most famous Japanese scientist in the field of quality, a typical representative of a successful takeover of all U.S. experiences, their immediate implementation in the study. Binding U.S. knowledge with the Japanese practice, Kaoru Ishikawa is a pioneer in winning new, own techniques that will celebrate Japan in the world.

For his work Ishikawa received a number of Japanese and international recognition, and it is enough to point out Deming Prize and the Shewhart Medal, Award of the Japanese Association for Standardization and Grants award of the American Society for Quality Control. In addition to a large number of papers and classes on videotape, Kaoru Ishikawa also wrote a series of books of which are still two world bestseler:

- ✓ *How to take quality circle activities,*
- ✓ *What is total quality control - the Japanese way.*

It is particularly important his work of introducing quality basis on practical circuits actions in Japan and worldwide, primarily in the United States. American Society for Quality is in 1993. established an annual award for the Ishikawa human aspect in the introduction and implementation of activities related to quality. The basic elements of learning and practice Kaoru Ishikawa are as follows:

1. *Quality begins and ends with learning*
2. *The first step is to find consumer demands*
3. *The ideal state of quality control occurs when inspection is no longer needed.*
4. *You must remove the causes of the problem, not the symptoms.*
5. *Quality control is the responsibility of all workers and all divisions.*
6. *Must not confuse means and ends.*
7. *Quality should be a priority and should seek to realize profits in the long term*
8. *Marketing is input and output for quality*

9. *Top management must not show anger when facts subordinate amounts.*
10. *95% of the problems in the organization can be solved using a simple tool for analyzing and troubleshooting.*
11. *The data do not indicate to the dispersion (ie. variability) were incorrect data.*

With the full support of the Association of Japanese scientists and engineers Ishikawa has proposed the implementation of quality statistics in three basic levels:

- ✓ *for all employees,*
- ✓ *for the leadership at all levels of superior quality managers,*
- ✓ *for professional statisticians.*

He advocated collection and analysis of data using simple visual tools, statistical techniques and teamwork as the basis for the introduction of total quality. Deming took the famous Shewhartov cycle (PDCA – Plan, Do, Check, Act) and adapt it to his way of thinking so that today is usually talking about the Deming cycle in four steps.

Kaoru Ishikawa further expanded it to six steps under the motto 'always (at least) one step further'. Ishikawa circle of improving quality consists of the following six steps:

1. *determine (define and detect) targets,*
2. *find methods to achieve goals,*
3. *get involved maximum in education and training,*
4. *achieve the goal (model products or services, processes, systems),*
5. *check and correct the results of the implementation of all existing improvements,*
6. *finally realized envisaged goal (improvement, new product or service, process, system)*

Move 'one step further', according to Ishikawa is pure fiction unless there is full support for all levels indicators that management must demonstrate their full commitment to quality. Kaoru Ishikawa is in a way a complete Japanese version and amendments Edward Deming. His role and importance in the development of quality in Japan is crucial and fundamental.

Combining the best of the West and the East, Ishikawa, along with top American experts charted the path will go complete Japanese economy and not just one. With all achieved practical success in statistics, quality control circles and total quality control of the entire company, Ishikawa will remain known as a top promoter of new techniques and technologies and harnessing more importantly as a convinced supporter of paying special attention to the man, his environment and the democratization of all production processes.

2. CAUSE – EFFECT DIAGRAM

2.1. Areas of application

***Cause – effect** diagram is the result of a general analysis of the impact (cause) that cause a particular outcome observed phenomena (work processes). In an effort aimed at boosting the quality of products and processes companies and service organizations, the present method has a wide range of applications in the processes of quality assurance processes of all functions of the company in terms of:*

- ✓ *Identification of the actual causes of a particular condition (**outcome**) results from the operation of the company or service organizations*
- ✓ *Identification and analysis of **cause – effect** relationship in the flow of materials, energy and information, which provide the basis for effective troubleshooting if as a result is observing the situation – the outcome of the work beyond the limits of tolerances os set objective function.*

2.2. Description

*Diagram of the **causes – effects** is, as noted, a method for detailed analysis of the relationship between a state system in observation (effects) and the influential variables that cause the occurrence of a given condition (**cause**). When given in the analysis related to improving the quality of the products and processes of companies and service organizations, the expression:*

- ✓ ***EFFECT** – means a certain **outcome** of the work of the observed view of the system at a given time and under given circumstances; as impact outcomes related to the effect of temperature and disorder in the process, it is clear that the size of the random character and can be classified into two main categories – **both inside and outside** the limits of tolerances placed objective function,*
- ✓ ***CAUSES** – means a set of environmental conditions and processes of the system that result in a particular state of the **outcome** of the*

work: from the standpoint of achieving the projected state – effects that are the size of circulation resulting character.

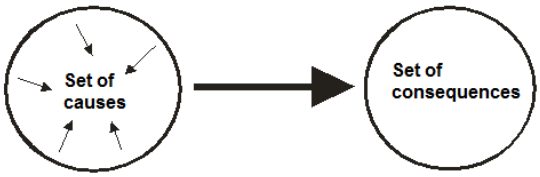

Figure 1. The main connection CAUSES – EFFECT

*Diagram of **Causes – Effect** as a set of causes on the one side and effect at the other side shall be regulated by the principles of:*

- ✓ ***Selection –** the separation of the true causes of a particular outcome of the work process – one effect,*
- ✓ ***Sorting –** grouping selected causes by character, importance and effection mode,*
- ✓ ***Logical connection** of the observed effects and causes of isolated.*

2.3. Procedure

*Step 1: **Defining the problem***

*In most cases the diagram **CAUSES – EFFECTS** are used for the case that resulted in defining a specific problem – poor quality parts, assemblies or products, the occurrence of **FAILURE CONDITIONS**, the long duration of the production cycle, low coefficient of rotation of capital, and a series of other related problems. Then it is necessary to verify the identity of the causes of occurrence of a trouble as a result. It is possible, also, a situation that results in a defined and particular effect. In this case seeking identification of the conditions that lead to the realization of the given effect as a result.*

EFFECT (problem or effect) must be defined on the basis of objective data in the form of a completely clear. In the process of defining the problem helps Brainstorming analysis.

Graphically present the given consequence – the usual symbol is a rectangle in the right part of the drawing in the manner shown in Figure 2, leaving the left side area of the diagram of the future introduction of the cause

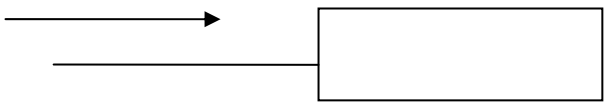

Figure 2. Define the problem – the EFFECT

*Step 2: **Identification of the cause***

A method for identifying the cause which lead to the problems defined above is composed in:

- ✓ *Forming the problem of all possible causes of the problem to be analyzed. It is obvious that an overview can be the result of a consequence, groups or professional teams, but at this stage recommend the results previously held Brainstormng session. When given the importance of the overview of the causes is complete, that is, goes off in advance of a cause which in subsequent analysis may result in the basic cause – and effect relationship.*

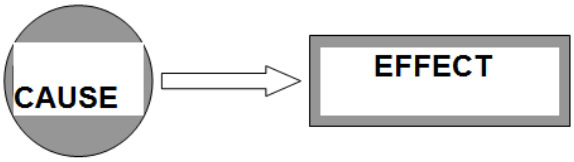

Figure 3. The basic form of cause – effect relationships

Classification by type of the cause, effection mode and related features.

Classification is the most effective use of simple forms of classification systems – coding sample: groups of causes related to the participants in the work, groups of causes related to materials, groups of causes related to the working procedures, groups of causes related to the means of work.

*Step 3: **Selection the basic structure***

*For non–production application forward given structure group **(4M)** obviously does not correspond – it takes depending on the nature of the problem, to form a new group.*

*If you previously added to the structure given category **Marketing**, **Money**, and **Management** structure then transferred to the structure type 7M.*

*The present stage of the analysis involves the selection of a certain structure **CAUSES – EFFECT** diagram. Structure type **4M** or **7M** can be a good basis for forming the basic structure of the diagram, where the adopted structure (number and nature of groups of causes) may not be final because the further development permit modification. The main groups of samples are entered by pulling the appropriate lines on the line effection causes diagram in step 1., to provide the basic structure diagram **CAUSES – EFFECT** given in Figure 4.*

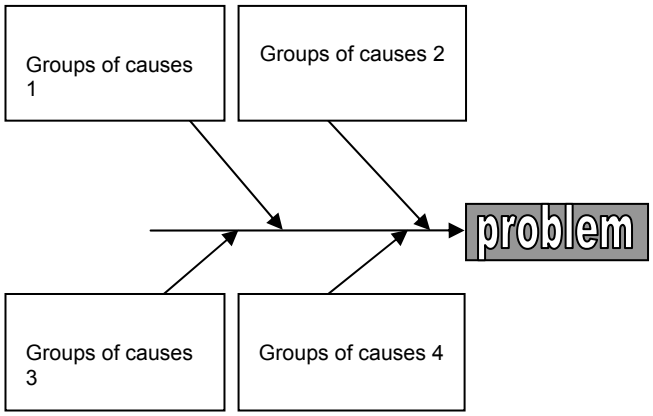

Figure 4. Basic structure of Causes – Effect diagram

Step 4: ***Develop a diagram***

For selected basic structure diagram should be the main groups of causes lines to add causes of which are previously located in the group. The addition is carried out by pulling each of the sample connection line in the basic group of the cause, as shown in Figure 5.

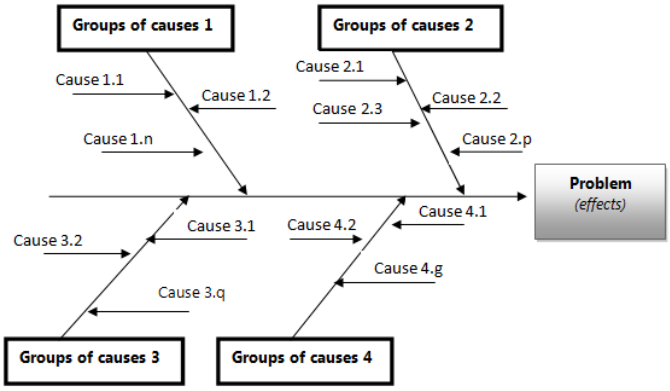

Figure 5. Development phase of Causes – Effect diagram

In the present step, it is necessary to make adjustments of the basic structure diagram in case of occurrence of the cause the concentration of one or two basic groups of the branches the cause (unbalanced diagram). You have acquired a basic insight into the effect of certain causes, the need of their allocation or elimination in cases of unnecessary connections.

Based on the foregoing it can be concluded that the elaborate diagrams need to respect the principles ofe:

- ✓ *Balanced structure*
- ✓ *The necessary minimum of the cause or cause – effect relationship.*

Step 5: ***The process of spreading (branching)***

A method of spreading is performed from the cause connected in multiple stages, without limitation, as long as it does not exhaust all the examination of identified causes.

Step 6: ***Analysis***

When by entering in diagram at a certain level exhaust all identified causes and check the logic of each of the branches, the approach to the analysis that is performed is in two directions:

- ✓ *Identification of the most likely cause–problem which is analyzed and their designation in the diagram. Probable cause should seek on the line: the bigest level causes – the highest level causes – lower levels causes,*
- ✓ *Given process, in addition to targeting the root causes of problem, allows, in certain cases, finding* ***the critical line cause****, which is certainly one of the most important results of this method,*
- ✓ *Diagram CAUSES – EFFECT considered separately is not sufficient to solve the problem – it only refers to its underlying causes, and the cause – effect relationships.*

For these reasons it is necessary to collect data in order to check the most important (most probable) cause and troubleshooting any other suitable method (ABC or Pareto diagram).

3. EXAMPLE DIAGRAM CAUSE – EFFECT IN THE TECHNOLOGICAL PROCESS OF CUTTING LOGS

Step 1 ***– Identify effects***

We need to identify and clearly define the output or effect *that will be analyzed. The effects should be formulated as a special quality characteristics, problems resulting in the work, planned objectives, etc.*

We must use the definition. *Within the team we have to determine the definition of effects to ensure that it is clearly and unambiguously understood.*

We need to know that the effect can be positive (objective) or negative (a problem)*, depending on the issue under discussion. The use of positive effects that focuses on the desired output can create an optimistic atmosphere that encourages the participation of team members. Whenever possible recommended expression effects in a positive way. Focusing on the negative effects can turn team effort to search justify why the problem occurred and determination of guilt. However, in some situations, for it is easier to*

focus on what are the causes of problem, but what are the causes of a positive output. The team needs to decide which approach is best for a particular case.

NOTE: *An example used to explain the construction of a „diagram of cause–effect" is divided into its component parts and described in detail to illustrate the construction steps. Using this example, we will show the causes that are related to getting poor quality boards when cutting logs.*

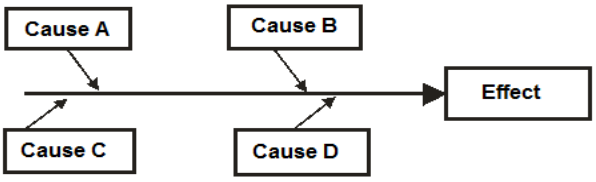

Figure 6: The basic structure of the cause–effect diagram

Step 2 ***– Drawing effects***

Using a board or larger paper, placed so that each team member can well see, than draw the BASIC STRUCTURE and create a effects RECTANGLE. Draw a horizontal arrow to the right end. This is the basic structure.. Right from the arrow write a brief description of effects or the output that results from the process (eg: a ***effect*** *is* ***poor quality of the boards****– Figure 7). Draw a rectangle around a description of the consequences.*

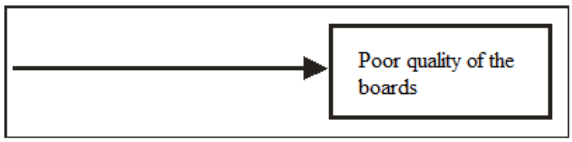

Figure 7. Step 2 – Drawing „effects"

Step 3 ***– Identify the causes***

Identifying main CAUSES that contribute to the effects that we analyze. These are signs of the main parts of our diagram and become categories that will be given reasons related to that category.

Determine the main causes, or categories, which will be referred to other possible causes. You need to use a label for a category that makes sense to create a diagram. Here are some commonly used categories:

- ✓ *3M and O – methods, materials, machines and staff,*
- ✓ *3P and O – politics, processes, facility and staff,*
- ✓ *Environment – potentially significant fifth category.*

Write down the main categories that our team chose the left of the effect rectangle, above and below the «basic structure».

Draw the rectangle around the label of each category, and connect them with the «basic structure» slanted lines.

Step 4 ***– Identification of other factors***

For each of the main group, identifying other specific factors that can be CAUSES EFFECTS:

- ✓ *Identify as many causes or factors and attach them as a subgroup of the main group (eg. possible causes for the poor quality of the boards are shown under the appropriate categories in Figure 9.).*
- ✓ *Provide details for each cause. If a cause of lower order applied to several causes higher order please include it below each of them.*

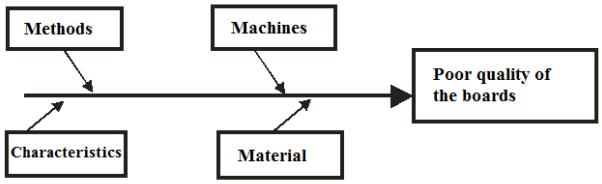

Figure 8. Step 3 – Identification of the major categories

Step 5 ***– Identify the causes***

We need to identify the deeper causes and to continue to organize under the appropriate causes or categories. We can do a series of questions asking ***why****.*

Figure 9 shows how the diagram looks like when all the causes have been identified that contribute to the effect. As you can see there can be many causes that contribute to the level of effect.

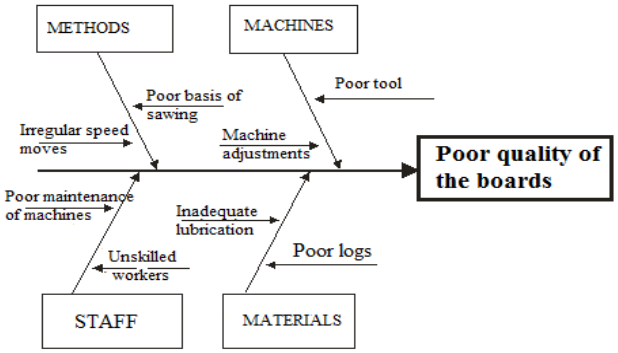

Figure 9. Step 5 – identifying the causes

Step 6 ***– Analysis of the diagrams***

The analysis helps to identify causes that warrant further investigation. Because „diagram cause–effect" identifies a ***possible cause****s of this further work we can use Pareto diagram to determine the cause of which will be the first focus. When*

analyzing the diagram we need to do the following:

- *Consider «balance» in our diagram by checking comparable levels of detail for most categories*
  - ✓ *A thin block position in one area may indicate that further research is needed.*
  - ✓ *Main category that has only a few specific causes may indicate the need for further identification of causes.*
  - ✓ *If several major groups have just a subset of them may be combined under one category.*
- *We need to seek the causes that are repeated several times. They may represent the root of the problem/effects.*
- *We need to seek what we can measure in each cause so that we can quantify the effects of changes that may make.*
- *Most importantly, identify and round up the cause in which we can take action.*

Analysis of diagram indicates the following:

The level of detail is almost balanced. No cause is not repeated. Invalid moving speed may be the cause of which it is possible to establish a measurement. Moreover, the wrong speed moves the cause in which we can take action. In Figure 10., is rounded to be marked for further investigation.

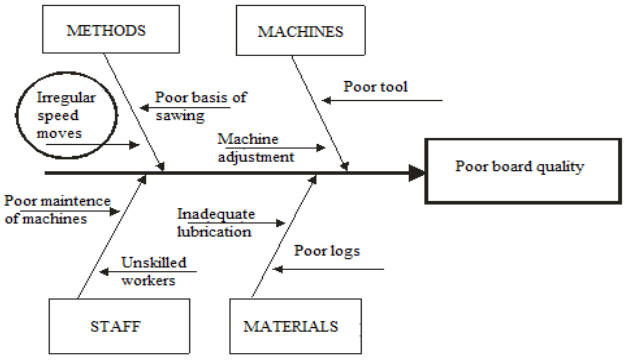

Figure 10. Step 6 – Diagram analysis

8. CONCLUSION

Strive for continuous improvement of quality, then work to meet the wishes and expectations of customers, through the reduction of variability in all processes, and improve process capability, and as a result will be an increase in the quality of products and/or services. The principle of continuous improvement can be carried out if leaders of business processes has adequate information base, which would enable them to make business decisions based on facts.

Cause–effect diagram is a tool that is suitable for identifying and organizing the known or possible causes of poor quality or problems. The structure provided by the diagram helps team members to think in a systematic way.

Cause–effect diagram is a tool that helps in identifying, sorting and displaying possible causes of a specific problem or quality characteristic. It graphically illustrates the relationship between a given output, and all the factors that affect the output. This type of diagram is sometimes called the „Ishikawa diagram" because it was invented by Kaoru Ishikawa or „fishbone diagram" because of his look.

In this paper, is a complete processed diagram causes – effect, his scope, description and method of making diagrams. It was made an example that indicates all the causes that affect the result of getting poor quality of cut

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